Physics 152 Roster No.:_________________________

Score:_________29 points possible_____

FALL 2005 Midterm Exam #2, Part A

Exam time limit: 50 minutes. You may use a calculator and both sides of ONE sheet of notes, *handwritten only*. Closed book; no collaboration.

For multiple choice questions, circle the letter of the one best answer (unless more than one answer is asked for). **Show your work** on all free-response questions. Be sure to use **proper units** and **significant figures** in your final answers.

Ignore friction/air resistance, gravity, and relativistic effects in all problems, unless told otherwise.

Physical constants:

$k_e = 8.988 \times 10^9$ N·m^2/C^2 $e = 1.602 \times 10^{-19}$ C $m_e = 9.109 \times 10^{-31}$ kg

$\varepsilon_0 = 1/4\pi k_e = 8.854 \times 10^{-12}$ C^2/(N·m^2) $m_p = 1.673 \times 10^{-27}$ kg

$\mu_0 = 4\pi \times 10^{-7}$ T·m/A

Useful conversions: 1 T = 10^4 G

1. (8 pts.) **Convert** the following quantities into the given units. Fill in the blanks. (You do NOT need to show your work.) Use *scientific notation* where appropriate (very large or very small values), and express all final values to *2 significant figures*.

a. 4.5×10^8 mΩ = ____________________ MΩ

b. 65 kG = __________________________ T

c. 3.2×10^{-6} T = ______________________ mG

d. 19,000 kg/m^3 = ____________________ g/cm^3

2. (2 pts.) All of the following statements are true **EXCEPT** which one?

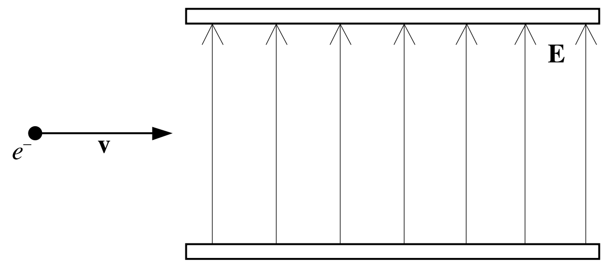
A. Magnetic poles always exert a repulsive force on "like" magnetic poles.
B. In ferromagnetism, a "domain" of atoms have their magnetic poles all aligned with each other.
C. Isolated magnetic N poles or S poles are occasionally found in nature, but they are not as common as isolated + or – charges.
D. The ferromagnetic property of iron oxide (rust) is used for storing information on cassette tapes, credit cards, and computer disks.

3. (1 pt.) Which one of the following most closely approximates the magnitude and direction of the **Earth's magnetic field** through this room right now?

A. 1 G, straight down, into the floor
B. 1 G, toward geographical North, parallel to the ground
C. 1 G, toward geographical South, parallel to the ground
D. 1 T, straight down, into the floor
E. 1 T, toward geographical North, parallel to the ground
F. 1 T, toward geographical South, parallel to the ground

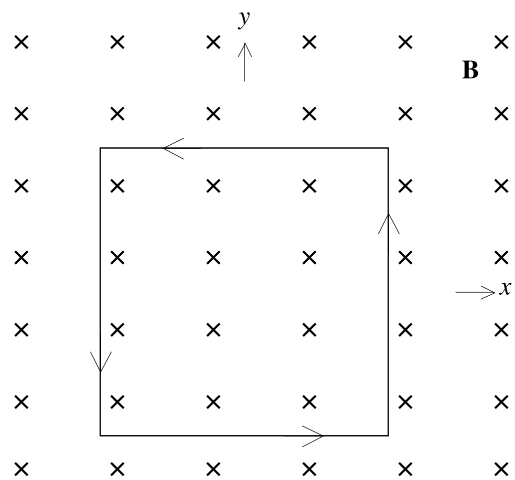
4. (2 pts.) An electron enters a region of uniform upward **E**-field, as shown at right. In which **direction** should you superimpose a **B-field** in the *same* region, so that the electron's path through the region remains *straight*?

A. upward (toward top of page)
B. downward (toward bottom of page)
C. into the page
D. out of the page
E. to the right
F. to the left



5. (2 pts.) A square wire loop in the plane of the page carries a constant current *counter-clockwise*, as shown at right. A uniform **B** field points *into the page*. This loop experiences a **net torque**...

A. about its *x*-axis
B. about its *y*-axis
C. clockwise
D. counter-clockwise
E. zero net torque



6. (1 pt.) A wire loop initially carrying no current is placed in a uniform external magnetic field. When the loop is mechanically turned end-over-end, an AC emf arises in the loop. Such a device is **called** a/an…

A. motor
B. transformer
C. transducer
D. inductor
E. solenoid
F. generator

7. Your portable CD player uses a transformer with an input of 66.7 mA and 120. V. (Assume 100% efficiency.)

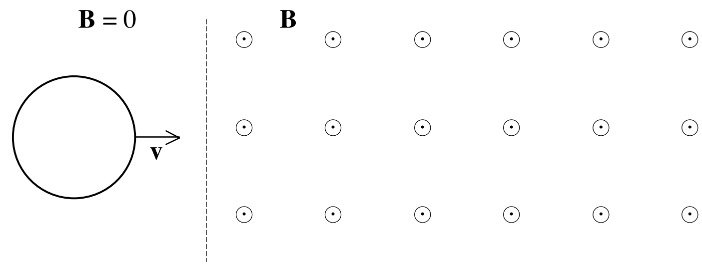
a. (2 pts.) If the transformer's output current is 1.33 A, what is the **output voltage**?

A. 0.90 V
B. 1.5 V
C. 3.0 V
D. 4.5 V
E. 6.0 V
F. 9.0 V

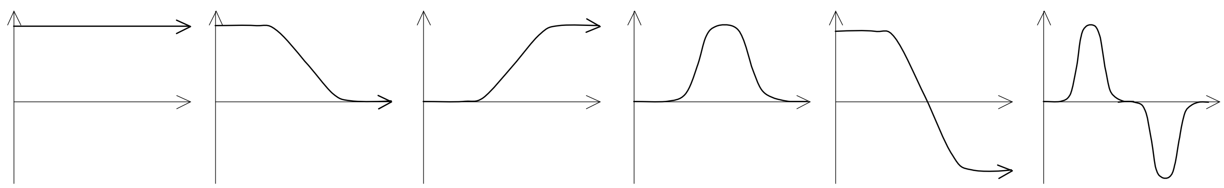
b. (1 pt.) This transformer is being used as a:

A. step-up transformer
B. step-down transformer
C. neither

8. A rigid, circular wire loop is moved at a *constant velocity* **v** from a region of zero **B**-field into a region of uniform out-of-the-page **B**-field, as shown at right. (The uniform **B**-field fills *all* of space to the right of the dashed line.)



a. (2 pts.) Which one of the following graphs best represents the **emf** induced in the loop as a function of time? ***Circle one graph:***



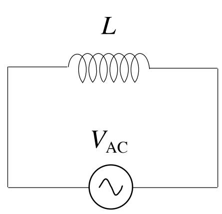
b. (1 pt.) Just as the loop begins to enter the uniform **B** region, in which **direction** does the induced current flow?

A. clockwise B. counter-clockwise C. no current is induced

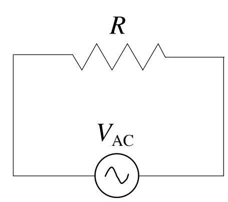
c. (1 pt.) In order to keep the loop moving at the constant velocity shown, you must apply a mechanical **force** on the loop in which **direction**?

A. to the left
B. to the right
C. out of the page
D. into the page
E. downward (toward bottom of page)
F. upward (toward top of page)
G. no force is needed

Circuit *A*:



Circuit *B*:



9. Both of the above circuits have 120-volt-rms, 60.-Hz AC voltage sources. In circuit *A*, the inductor has L = 580 mH.

a. (3 pts.) What is the **rms current** in circuit *A*?

A. 0.91 mA
B. 2.0 mA
C. 33 mA
D. 290 mA
E. 550 mA
F. 2.6 A

b. (2 pts.) If you *increase* the *frequency* of the AC sources in *both* circuits, which **one** of the following would happen?

A. The impedance of the inductor would increase, and the resistance of the resistor would also increase.
B. The impedance of the inductor would increase, while the resistance of the resistor would decrease.
C. The impedance of the inductor would increase, while the resistance of the resistor would not change.
D. The impedance of the inductor would decrease, while the resistance of the resistor would increase.
E. The impedance of the inductor would decrease, and the resistance of the resistor would also decrease.
F. The impedance of the inductor would decrease, while the resistance of the resistor would not change.

c. (1 pt.) All of the following statements are true **EXCEPT**:

A. In circuit *A*, the voltage source's emf is "out of phase" with the current flowing in the circuit.
B. In circuit *A*, the inductor dissipates energy over time.
C. In circuit *B*, the voltage source's emf and the current flowing in the circuit are "in phase."
D. In circuit *B*, the resistor dissipates energy over time.

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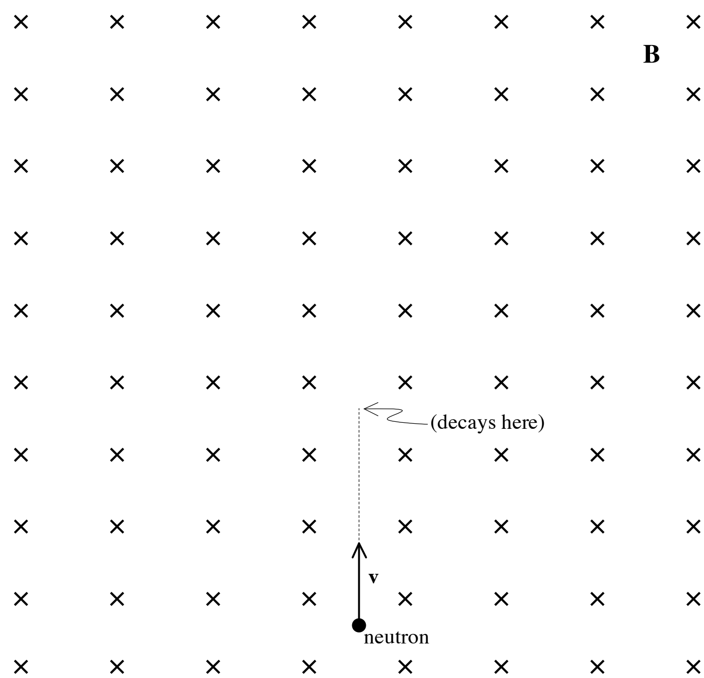
Score: ______**21 points possible**______

FALL 2005 Midterm Exam #2, Part B

1. A free neutron is traveling in the plane of the page, straight up (toward the top of the page), at a constant speed of 2.0×10^7 m/s. It is inside a uniform **B**-field of 0.50 T directed into the page. At the point noted at right, the neutron suddenly decays, becoming a proton and an electron. Assume that the two new particles both continue upward with the same velocity as the neutron had. (Ignore friction, and ignore any electrical force between the particles.)



a. (4 pts.) Calculate the **radius**-of-curvature of the path that the new *proton* will follow.

b. (1 pt.) The proton will trace out a circle in which **direction**?

A. **clockwise** B. **counter-clockwise**

c. (2 pts.) The **electron's circle** will have _________________________ as the proton's circle.

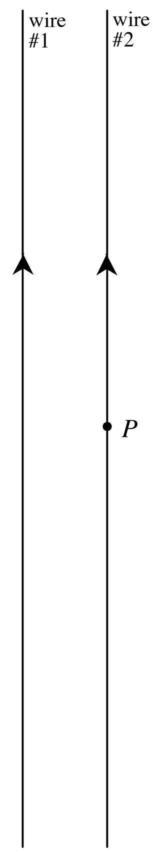
A. same radius and same direction of circulation
B. smaller radius and same direction of circulation
C. greater radius and same direction of circulation
D. same radius and opposite direction of circulation
E. smaller radius and opposite direction of circulation
F. greater radius and opposite direction of circulation

d. (2 pts.) **Draw** your predicted **paths** for *both* the proton and the electron on the diagram above, starting from the point where they are created by the neutron's decay. **LABEL the paths "proton" and "electron".** Use your answers above as a guide for their relative curvatures. Include directional **arrowheads** on the paths. (Ignore any friction on the particles.)

e. (1 pt.) **Why** did the *neutron's* original path inside the **B**-field have **no curvature** (i.e., was a straight-line path)?

A. The neutron's mass is zero.
B. The neutron's mass is nearly infinite.
C. The neutron's charge is zero.
D. The neutron's angle between **v** and **B** was 90°.

2. Two parallel wires, 3.0 m long, fixed 2.5 cm apart, lie in the plane of the page and carry identical currents of 40. A in the same direction, as shown.



a. (4 pts.) Ignoring wire #2 for the moment, determine the **strength** of the **magnetic field** generated by wire #1 *at point P* (located at a distance of 2.5 cm to the right of wire #1).

b. (1 pt.) The **magnetic field** calculated in part (a) has which **direction**?

A. to the right
B. to the left
C. toward top of the page
D. toward bottom of the page
E. into the page
F. out of the page

c. (4 pts.) Now, consider both wires. What is the **magnitude** of the **force on wire #2**?

d. (1 pt.) The **force** calculated in part (c) has which **direction**?

A. to the right
B. to the left
C. toward top of the page
D. toward bottom of the page
E. into the page
F. out of the page

e. (1 pt.) As the currents flow, the two wires ______________________ each other.

A. **attract**
B. **repel**
C. **neither** attract nor repel